THE EFFECT OF LOW GLYCEMIC INDEX DIET IN REDUCING HBA1C LEVELS IN ADULTS WITH TYPE 2 DIABETES: A SYSTEMATIC REVIEW

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Abstract

Background: Diabetes, as defined by medical standards, is a set of metabolic diseases characterized by continuously elevated blood sugar levels. Extended periods of elevated blood sugar can negatively affect various organs, like the eyes, kidneys, nerves, heart, and blood vessels, leading to potential dysfunction. The condition is mainly divided into two types: type 1 diabetes (T1D) and type 2 diabetes (T2D). Additionally, the glycemic index (GI) is a key measure used to assess carbohydrates in foods. Foods are rated on a scale from 0 to 100, with higher GI values indicating a greater increase in blood glucose levels. A low GI diet typically maintains an average glycemic index around 40 units.

Methods : The research approach involved querying two databases, PubMed and Medline, utilizing specific keywords: (((Low glycemic diet) OR (low GI diet)) AND (Diabetes)) OR (T2DM). Selection of studies adhered to the guidelines of the Preferred Reporting Items for Systematic Reviews (PRISMA, 2020).

Results: Five randomized controlled trials (RCTs) investigated the effects of low glycemic index (GI) diets on people with type 2 diabetes. The studies showed that low GI diets, either as full diets or specific meals, generally led to reductions in HbA1c levels, a key indicator of blood sugar control. In addition to improved glycemic control, some trials also reported reductions in body weight and cholesterol levels. However, the extent of these changes varied among studies, with some showing more significant results than others.

Conclusion : While this diet might improve glycemic control and reduce HbA1c levels, its practicality and efficacy is questionable due to variations in study designs, GI food values, and individual metabolic responses. Small sample sizes and short studies raise doubts about the long-term effectiveness of low GI diets. Studies suggest limited impact on long-term glycemic control and cardiovascular risks, and adherence to this diet can be challenging.

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Introduction

The World Health Organization (WHO, 2019) defines diabetes as a collection of metabolic disorders marked by persistent high blood sugar levels. This chronic hyperglycemia can cause harm to multiple organs, particularly affecting the eyes, kidneys, nerves, heart, and blood vessels, potentially leading to their dysfunction. Diabetes is primarily categorized into two main types: type 1 diabetes (T1D) and type 2 diabetes (T2D). This classification hinges on various distinguishing factors between patients with T1D and T2D. These include the age when the disease begins, presence of obesity, the extent of insulin resistance (IR), occurrence of metabolic syndrome (MS), the level of deterioration in pancreatic β-cell function, the existence of specific autoantibodies linked to β-cell damage, the presence of a subclinical inflammatory state throughout the body, blood levels of C-peptide, and the necessity of insulin treatment for survival (Leslie et al, 2016). Approximately 422 million individuals globally suffer from diabetes, mostly in low- and middle-income countries, diabetes is the direct cause of 1.5 million deaths every year. In recent decades, there's been a steady increase in the number of diabetes cases and its prevalence (WHO, n.d). Numerous occurrences of T2D are preventable through modifications in lifestyle. This includes keeping a healthy body weight, eating a nutritious diet, engaging in regular physical activity, abstaining from smoking, and moderate consumption of alcohol. The majority of individuals suffering from T2D experience at least one health complication, with cardiovascular issues being the primary reason for increased illness and death rates in these patients (Zheng et al, 2018).

The Gulf Cooperation Council countries, including Saudi Arabia, Kuwait, Bahrain, Oman, Qatar, and the United Arab Emirates, are identified as having one of the highest rates of diabetes mellitus in the world (Al Dawish et al, 2016). In Gulf countries, the prevalence of diabetes among adults aged 20 to 79 years varied between 8% and 22%. Kuwait had the highest prevalence rate in the GCC at 22%, while the greatest number of diabetes-related deaths occurred in Saudi Arabia (Aljulifi 2021). HbA1c, also known as glycated hemoglobin, is commonly used to estimate average blood glucose levels. Prior research has demonstrated a linear relationship between average glucose levels and HbA1c values. This means that as average blood glucose levels increase, so do HbA1c values, and vice versa. This relationship is crucial for understanding and managing diabetes, as HbA1c provides a long-term indication of blood glucose control, reflecting average glucose levels over the past two to three months (Kameyama et al, 2018).

The glycemic index measures a food's specific attribute related to carbohydrates. It is expressed as a percentage or index reflecting the nature of carbohydrate in foods, food items are assessed on a scale of 0 to 100 using the glycemic index (GI), where those with higher GI values are associated with a more significant rise in blood glucose (Augustin et al, 2015). As for the low GI diet it is usually a diet with mean glycemic index of 40 units (Kelly et al, 2011) (Malin et al, 2012). Foods high in glycemic index scoring 70 or more like white bread, many types of breakfast cereals, and potatoes, are quickly processed and absorbed, causing a rapid and notable surge in blood sugar levels. Medium GI foods, which have a glycemic index ranging from 56 to 69, include specific fruits, dairy items, and grain-based products, leading to a moderate increase in blood sugar due to their intermediate rate of digestion and absorption. Conversely, low-GI foods, scoring 55 or less, such as a majority of legumes, non-starchy vegetables, and certain fruits, are absorbed and digested slowly, resulting in a more gradual and lesser rise in blood sugar (Atkinson et al, 2021). In order to enhance glycemic control, reduce LDL-cholesterol, and lower cardiovascular risk, it is recommended to prioritize foods that are high in fiber 30–50 grams per day with at least 30% being soluble fibers, and those that are minimally processed with a low glycemic index (Petroni et al, 2021). Many diet approaches have been suggested to control blood sugar level in T2D patients, Zafar et al 2020 claims after the analysis of 54 studies shows that low GI diets offer benefits over other diet types for individuals with impaired glucose tolerance or diabetes. Specifically, claimed that the diet is effective in reducing HbA1c, fasting blood glucose (FBG), body mass index (BMI), and blood lipids. The aim of this review is to look further in using low GI diet intervention to control blood sugar level and improve the overall health of patients with T2D including weight and biochemistry values.

Methods

The search strategy was used on two databases: PubMed and Medline. The following keywords were used in the search: (((Low glycemic diet) OR (low GI diet)) AND (Diabetes)) OR (T2DM). The studies included were selected in accordance with the Preferred Reporting Items for Systematic Reviews guidelines (PRISMA, 2020), as shown in Figure 1.

The PICO model was followed in this review:

- Population: Adults with type 2 diabetes.
- Intervention: low glycemic index diet.
- Comparison: Control groups.
- Outcome: changes in HBA1C.
- Inclusion Criteria

1. RCTs.
2. Published between 2014 and 2023.
3. Adults with type 2 diabetes only.
4. studies using low glycemic diet as an intervention.
5. Studies written and published in English.

- **Exclusion Criteria:**

1. Non-RCT studies.
2. Published before 2014.
3. Studies in children.
4. Studies not in English.
5. Adults with different types of diabetes.

Primary Outcome

The focus of this study was primarily on changes in HBA1C.

Secondary Outcomes

The secondary outcomes were changes in body weight (KG) and changes in total cholesterol.

Results:

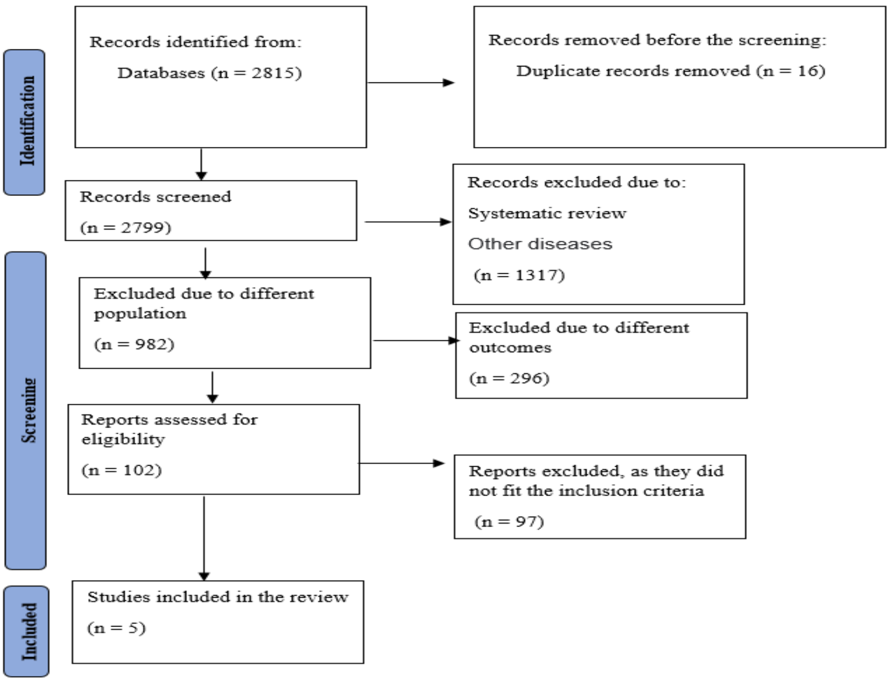
Quality Assessment

The quality assessment was conducted using the modified Cochrane Collaboration tool to evaluate the risk of bias of RCTs (high, low, or unclear) on five domains (randomization process, intended intervention, missing outcome, outcome measurement and selection of results). (Sterne et al., 2019). See table1.

Table1.

Biases / Authors	Randomization process	Intended intervention	Missing outcome	Outcome measurement	Selection of results	Overall risk of bias
Argiana et al, (2015).	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Li et al, (2014).	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	High risk
Pavithran et al, (2020).	Some concerns	High risk	Some concerns	Some concerns	Some concerns	High risk
Stenvers et al, (2014).	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Visek et al, (2014).	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	High risk

Figure 1: PRISMA flowchart demonstrating the selection of articles included in the review



From 5 RCTs reviewed in this paper published between 2014-2023 in different countries that studied the effect of low glycaemic index diet on reducing HBA1C, body weight and total cholesterol levels. with a total number of 221 individuals diagnosed with type 2 diabetes as shown in table2.

Table2:

Author's	Location	N of participants	Intervention	Duration	Outcomes	Comments
Argiana et al, (2015).	Greece	61	4 portions of low glycemic desserts per week	12 weeks	HBA1C P= 0.005 Body weight P<0.001	Not exclusively low GI diet. Short period.
Li et al, (2014).	China	71	Low GI multi nutrient breakfast supplement	12 weeks	HBA1C P= 0<0.001 Body weight P=0.07 Cholesterol P=0.267	Not exclusively low GI diet. High dropout rate.
Pavithran et al, (2020).	India	40	Low GI diet plan or usual diet (control group)	24 weeks	HBA1C P<0.05 Body weight P<0.05 Cholesterol P=0.116	Small number of participants. Good follow up using multiple dietary recall.
Stenvers et al, (2014).	The Netherlands	29	Low GI replacement breakfast and control group.	3 months	HBA1C P=0.127 Body weight P=0.658 Cholesterol P=0.930	Small number of participants. Not exclusively low GI diet.
Visek et al, (2014).	Czech Republic	20	Low Gi diet compared to diabetic diet	9 months	HBA1C P is not significant Body weight P<0.05	Small number of participants.

Abbreviations: N= number, GI= glycemic index, HBA1C= glycated hemoglobin

Primary Outcome:

All of the 5 RCTs measured the changes in HbA1c after low GI intervention with two of them were exclusively low GI diet and the rest were low GI meals consumed regularly. The study by Argiana et al, 2015 was a 12-week, two-arm, randomized, controlled, prospective trial conducted in Greece with 61 participants who had T2D. It divided the participants into two groups: an intervention group and a control group. Both groups adhered to a low-calorie diet. However, the intervention group's diet included low-glycemic-index/low-glycemic-load desserts, whereas the control group was allowed to eat their regular sweets. The study measured glycosylated hemoglobin (HbA1c) levels at the beginning and at the end of the 12 weeks. Initially, the intervention group's HbA1c level was 6.6 ± 0.1%, and the control group's was 6.8 ± 0.2%. After 12 weeks, these levels changed to 6.3 ± 0.08% for the intervention group and 6.5 ± 0.1% for the control group. Similarly, the study by Di Li et al, 2014 was a randomized controlled trial conducted with 71 participants in China who had T2D. It divided the participants into two groups: a supplement group and a control group. Both groups maintained their usual diet, but the supplement group replaced their breakfast with a low glycemic index multi-nutrient supplement, while the control group consumed their regular breakfast. The primary outcome measured was the change in Hemoglobin A1c (HbA1c) levels. Initially, the supplement group's HbA1c level was 7.1 ± 1.0%, and the control group's was 7.2 ± 1.1%. After the intervention, these levels changed to 6.7 ± 0.9% for the supplement group and 7.1 ± 1.1% for the control group, indicating a significant reduction in the supplement group compared to the control group. Additionally, Pavithran et al, 2020 in their prospective randomized controlled study conducted over 24 weeks. It involved 40 participants with type 2 diabetes aged 35-65 years, who were recruited from the Department of Endocrinology and Diabetes Outpatient in Kerala, South India. Participants were randomly assigned equally with 18 participants in each group to either receive a low GI diet or a control group following their usual diet. The study aimed to examine the effects of a low GI diet, using local South Indian recipes, on body composition and glycemic control. participants on a low glycemic index diet experienced a reduction in HbA1c from a baseline of 8.28 ± 0.91% to 7.41 ± 0.89%, compared to the control group which had a baseline of 8.18 ± 0.98% and a result of 8.42 ± 1.16%. On the other hand, Stenvers et al, 2014 conducted a 3-month randomized controlled cross-over study in The Netherlands in, aiming to explore the impact of substituting a regular breakfast with a low-glycaemic response (GR) liquid formula of the same energy level. Initially, participants documented their food consumption for three days to calculate the average caloric value of their breakfasts. Subsequently, they were divided into two groups, one following a low-GR diet and the other a control diet, through block randomization. Each participant underwent one dietary regimen, followed by a one-month washout period, and then switched to the alternate regimen. At the start, the median HbA1C levels were 48 in both groups. After 6 weeks, there were no changes in these levels in either group, and by 12 weeks, it rose to 49 in the control group but remained unchanged in the intervention group, indicating no significant differences. To conclude the results, Visek et al, 2014 in their open-label randomized crossover study, involving 20 adults with type 2 diabetes in Czech Republic. The duration of the study was 9 months, divided into three 3-month periods. Participants were initially assigned to either a standard diabetic diet or a low glycemic index diet and then switched after each period. The baseline HbA1c values for the low GI diet group were 6.5% (ranging from 5.6% to 8.4%), midway through the study they were 6.63% (with a range of 6.08% to 7.0%), and by the end, they reached 6.72% (ranging from 4.91% to 7.7%). In contrast, for the standard diabetic diet, the HbA1c values commenced at 6.7% (with a range of 6.1% to 7.5%), reduced to 6.45% (ranging from 6.18% to 6.91%) at the study's midpoint, and finally decreased to 5.27% (with a range of 3.55% to 7.02%) by the study's conclusion.

Secondary Outcomes:

Looking at changes in weight and cholesterol levels in the 5 RCTs which were mostly significant for example, Argiana et al, 2015 Initially, at Week 0, the Low GI group had an average body weight of 87.5 ± 2.8 kg, which reduced to 84.8 ± 2.8 kg by Week 12, marking a change of −2.7 ± 0.5 kg. The control group, starting at 88.8 ± 2.5 kg, saw a decrease to 87.1 ± 2.5 kg over the same period, with a change of −1.7 ± 0.3 kg. This data indicates that both groups experienced a reduction in body weight, with the Low GI group showing a slightly larger average decrease, as for the changes in cholesterol level, there was a significant reduction in total cholesterol in the group following a low glycemic index diet. The Low GI group started with an average total cholesterol level of 136.6 ± 3.5 mg/dL, which decreased to 126.9 ± 4.2 mg/dL at the end of the study, marking a reduction of −9.7 ± 3.7 mg/dL. The control group also showed a reduction in cholesterol levels, from 141.4 ± 5.3 mg/dL to 135.1 ± 4.5 mg/dL.

In Pavithran et al, 2020 trial, the control group experienced a slight increase in weight, going from 73.12 ± 8.76 kg to 73.40 ± 9.03 kg, which is a mean change of +0.28 ± 1.48 kg. On the other hand, the LGI group experienced a decrease in weight from 67.91 ± 12.56 kg to 66.02 ± 11.05 kg, amounting to a mean change of -1.88 ± 2.85 kg. Regarding total cholesterol levels, there was a minor change in the control group, from 154.08 ± 34.11 mg/dL to 155.08 ± 38.89mg/dL. In contrast, the LGI group showed a notable decrease in total cholesterol levels, from 176.43 ± 38.75 mg/dL to 158.98 ± 31.91 mg/dL.

Furthermore, Di Li et al, 2014 also noticed changes in both weight and cholesterol levels, in the low GI group body weight at baseline was 87.5 ± 2.8 and decreased to 84.8 ± 2.8 after 12 weeks, as for the control group they also showed a decrease in weight but lesser than the intervention group, with average body weight of 88.8 ± 2.5 at baseline and 87.1 ± 2.5 at the end of the trial. Regarding the total cholesterol number, the intervention group showed a significant decrease from baseline 173.9 ± 6.4 to 167.0 ± 4.1, also a slight decrease was noticed in the control group from 176.6 ± 5.2 to 175.8 ± 5.2.

In addition, Stenvers et al, 2014 despite the relatively long intervention, body weight and total cholesterol showed no significant results as the median for body weight was 92.7 at baseline and 92.5 at the end of trial in the intervention group, and 92.6 at baseline for the control group and finished with an insignificant increase to 92.8. Looking at the total cholesterol levels with a median of 4.47 at baseline and 4.44 at the end in the intervention group, and for the control group numbers were 4.70 at baseline and 4.58 at the end.

Finally, Visek et al, 2014 trial showed that body weight experienced a reduction in the intervention group. Initially, it was 96 kg, which then dropped to 92 kg over the course of three months. At the six-month mark, it slightly increased to 92.4 kg, and after nine months, the weight reached 92.6 kg, in the diabetic group the weight decreases from 96kg to 93kg after 3 months.

Discussion

The analysis of the five RCTs on the effects of a low GI diet on individuals with Type 2 Diabetes

Mellitus offers a complex perspective on the management of this T2D. These studies involving a total of 221 participants from various countries, provide rich data for a comparative and critical appraisal. The study by Argiana et al, 2015 and the study by Li et al, 2014 both demonstrated significant reductions in HbA1c levels, indicating the potential of a low GI diet for effective glycemic control. However, the study by Argiana et al, 2015 focused on incorporating low GI desserts into the diet, whereas the study by Li et al, 2014 used a low GI multi-nutrient breakfast supplement. This contrast in dietary focus suggests that different low GI interventions can result in significant glycemic control, though the specific dietary elements and meal timing might influence the extent of this control. The study by Pavithran et al, 2020 with a duration of 24 weeks, providing a more extended observation of the diet's effects. This study, emphasizing a comprehensive low GI diet plan, reported reductions in both HbA1c and body weight. This longer term approach underscores the potential of sustained dietary changes for broader metabolic improvements in T2DM patients.

In contrast, the study by Stenvers et al, 2014 and the study by Visek et al, 2014 reported less pronounced changes in HbA1c levels. Stenvers et al, 2014 focused on altering only the breakfast meal with a low GI alternative possibly limited its impact on overall glycemic control. In comparison Visek et al, 2014 with a long term intervention of nine months, revealed no significant changes in HbA1c levels taking in consideration the high risk of bias and the limited number of participants.

In terms of weight loss, all the studies, except for the one conducted in the Netherlands, reported some degree of weight reduction in participants following a low GI diet. The study by Argiana et al, 2015 and the study by Li et al, 2014 observed reductions in body weight, though the Chinese study had a high dropout rate which might have impacted its results. The study by Pavithran et al, 2020 also reported weight loss, indicating the effectiveness of a comprehensive low GI diet plan over a longer period (24 weeks). On the other hand, the study by Stenvers et al, 2014 which involved only a replacement breakfast, did not report significant weight changes, highlighting that partial dietary modifications may be less effective than comprehensive diet plans. The study by Visek et al, 2014, lasting for 9 months' duration, also observed weight reduction. Regarding cholesterol levels, the results were more varied. The study by Argiana et al, 2015 found a significant reduction in cholesterol levels, suggesting a positive cardiovascular impact of low GI diets. However, the study by Pavithran et al, 2020 reported only a minor change in cholesterol levels. Similarly, the Li et al, 2014 observed a slight decrease in cholesterol levels in the intervention group, but not as significant as the Greek study. Stenvers et al, 2014 found no significant changes in cholesterol levels, while the Visek et al, 2014 did not provide data on cholesterol levels.

Zafar et al, 2020 systematic review and meta-analysis summarizes the findings from an analysis of 54 studies evaluating the effectiveness of low GI diets in managing diabetes, focusing on adults and children with impaired glucose tolerance, type 1 diabetes, or type 2 diabetes. they revealed that low glycemic index diets effectively reduced levels of HbA1c, fasting glucose, BMI, total cholesterol, and LDL cholesterol. However, they showed no significant impact on fasting insulin, HDL cholesterol, triglycerides, or the need for insulin. The greatest reductions in fasting blood glucose were observed in the longest-duration studies. However, despite the significant results in lowering HbA1c and body weight, low GI diet intervention in the trials reviewed by Zafar et al, 2020 are different in the type of dietary intervention, while some of the trials used exclusive low GI diet, some of them only used one low GI meal per day which impact the overall results and suggest the lack of inconsistency between the trials. In addition, low GI diet differ from one country to another which might affect the overall calorie intake and carbohydrate intake based on the different food items that can be consumed, this complicates the long adherence to this type of dietary approach.

Conclusion

In conclusion, this review provided an additional look into how low glycemic index diet affects different aspects in the treatment of T2D. While these diets have been shown to aid in improving glycemic control and reducing HbA1c levels, there are notable considerations and limitations that question the practicality and overall efficacy of such dietary interventions. Firstly, the heterogeneity in the design and implementation of the low GI diets across the studies raises concerns about the consistency and comparability of the results. Variations in dietary composition, duration of the interventions, and participant demographics make it challenging to draw generalized conclusions. Additionally, the variability in GI values of foods, influenced by factors such as preparation methods and individual metabolic responses, complicates the application of a low GI diet in a real-world setting. Moreover, the limited scope of some studies, particularly those with small sample sizes and short intervention periods, calls into question the long-term effectiveness and sustainability of low GI diets. The findings from studies like Stenvers et al, 2014 and Visek et al, 2014 suggest that the impact of low GI diets on long-term glycemic control and cardiovascular risk factors is not as significant as anticipated. This aligns with the raised concerns regarding adherence challenges, as strict dietary regimens can be difficult to maintain over extended periods, especially considering cultural and personal dietary preferences. Furthermore, the focus on low GI diets alone may overlook the complexity of diabetes management, which necessitates a more holistic approach. Factors such as total caloric intake, macronutrient composition, and lifestyle modifications are also critical components that play a role in the effective management of T2D. focusing on GI could lead to a disregard for these other essential elements of diabetes treatment.

In light of these considerations, it is crucial to approach the management of T2D with a more comprehensive strategy. While low GI diets can be part of the management plan, they should not be viewed as a standalone solution. Healthcare providers and patients should focus on individualized treatment plans that consider personal preferences, lifestyle factors, and overall nutritional balance. Future research should aim to provide more definitive guidance on the role of low GI diets within the broader spectrum of diabetes management strategies, taking into account long-term adherence, patient quality of life, and holistic health outcomes.

There are alternative dietary approaches for managing T2D that might be more suitable for certain individuals. For instance, Mediterranean, DASH (Dietary Approaches to Stop Hypertension), balanced calorie-restricted diet and low carbohydrate diet may offer comprehensive benefits that extend beyond glycemic control, including heart health, weight management, and overall nutritional balance.

In summary, while low GI diet can be a useful tool in the management of T2D, it is not without limitations and challenges. The effectiveness of a low GI diet may vary greatly between individuals, and a holistic approach to diabetes management, which includes consideration of dietary patterns, nutritional balance, individual lifestyle factors, and medical treatments, is essential. Healthcare providers should work closely with patients to develop personalized and practical dietary strategies that align with their individual needs, preferences, and medical goals.

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